1. Real Vs Nominal Interest Rate

ONCE WE INTRODUCE INFLATION, WE NEED TO DISTINGUISH BETWEEN REAL AND NOMINAL INTEREST RATES.

Nominal Interest Rate ($i$): rate at which you can transform dollars today into dollars tomorrow.

\[
(1+i) = \frac{\text{DollarsTomorrow}}{\text{DollarsToday}}
\]

Real Interest Rate ($r$): rate at which you can transform goods today into goods tomorrow.

\[
(1+r) = \frac{\text{GoodsTomorrow}}{\text{GoodsToday}}
\]

In the presence of inflation, the distinction is important: There is no point in receiving high interest payments in the future if inflation between now and then is so high that we won’t be able to buy as many goods as before.

**Computing the real interest rate**

\[
1+ r_t \equiv (1 + i_t) \frac{P_t}{P^e_{t+1}} \quad [1]
\]

Now, introduce expected inflation, $\pi^e_t$.

\[
\pi^e_t = \frac{P^e_{t+1} - P_t}{P_t} \quad \Rightarrow \quad \frac{P_t}{P^e_{t+1}} = \frac{1}{1+\pi^e_t} \quad [2]
\]

Introducing [2] in [1] leads to another definition of real interest rate:

\[
1+ r_t = \frac{1+i_t}{1+\pi^e_t} \quad [3]
\]

Now, when $i_t$ and $\pi^e_t$ are not too large (< 20% per year), a close approximation is:

\[
r_t \approx i_t - \pi^e_t \quad [4]
\]
2. How Does this enter the IS/LM Model?

Interest rates enter in two places

- Affects I in the IS relation
- Affects Money Demand in the LM relation

Now, which one is the appropriate interest rate?

**IS relation:**

I- firms care about real interest rate: they want to know how much they will have to repay, not in terms of dollars, but in terms of goods.

IS relation becomes: \( Y = C(Y-T) + I(Y,r) + G \)

**LM relation:**

Nominal interest rate is the important one in the determination of demand for money.

When thinking about whether to hold money or bonds, people take into account the opportunity cost of holding money rather than bonds (0 against i).

Therefore, we still have: \( \frac{M}{P} = YL(i) \)

**IS/LM Model now becomes:**

\[
\begin{align*}
\text{IS:} & \quad Y = C(Y-T) + I(Y,r) + G \\
\text{LM:} & \quad \frac{M}{P} = YL(i) \\
\text{int. rates:} & \quad r = i - \pi^e
\end{align*}
\]

Now, the model determines Y, i and r.

Can reduce it to a model of 2 equations in two unknowns, Y and r.

\[
\begin{align*}
\text{IS:} & \quad Y = C(Y-T) + I(Y,r) + G \\
\text{LM:} & \quad \frac{M}{P} = YL(r + \pi^e)
\end{align*}
\]
Graphically, the consequences are the following:

Now, the LM curve can be shifted by $\pi^e$.

In the same way, an increase in $\pi^e$ shifts the AD curve to the right.

3. The Phillips Curve

Recall the Aggregate Supply relation: $P_t = P^e_t (1+\mu) F (u_t, z)$

This relation can be rewritten as:

$$\pi_t = \pi^e_t + (\mu + z) - \alpha. u_t$$  \[5\]

$\alpha$ - reflects the effect of unemployment on inflation.

Relation [5] is basically the Phillips curve.

Early Incarnation:

In the period 1948-1969, the following equation fitted the macroeconomic data very well.

It assumes $\pi^e_t = 0$.

$$\pi_t = (\mu + z) - \alpha. u_t$$  \[6\]

This is the original Phillips curve.

But, from 1970 on, the relation broke down for two main reasons:

- ‘oil shocks’ of 70s ($\mu \uparrow$)
- Firms and workers changed the way they form expectations. This change came from a change in the process of inflation itself.
This change in expectations formation changed the nature of the relation between unemployment and inflation.

Suppose \( \pi^e_t = \theta \cdot \pi_{t-1} \) (our interpretation is that \( \theta \) increased over time).

\[
\pi_t = \theta \cdot \pi_{t-1} + (\mu + z) - \alpha u_t \tag{7}
\]

\( \theta = 0 \) -- original Phillips curve.
\( \theta = 1 \) -- modified Phillips curve or expectations-augmented Phillips curve.

\[
\pi_t = \pi_{t-1} + (\mu + z) - \alpha u_t \tag{8}
\]

Curve corresponding to equation [8] fits well the data for period 1970-94.

Now, the unemployment affects not the inflation rate but rather the change in the inflation rate.

**Natural rate of Unemployment**

Defined for \( \pi_t = \pi^e_t \implies u_n = \frac{\mu + z}{\alpha} \tag{9} \)

We get, \( \alpha u_n = \mu + z \)

replacing in [5], we have \[
\pi_t = \pi^e_t - \alpha (u_t - u_n) \tag{10}
\]

If \( \pi^e_t \approx \pi_{t-1} \) then \[
\pi_t - \pi_{t-1} = - \alpha (u_t - u_n) \tag{11}
\]

So, another definition for \( u_n \) can be: rate of unemployment required to keep inflation constant. That’s why it is also called nonaccelerating inflation rate of unemployment (NAIRU).

**US unemployment experience**

There are no reasons to believe that \( \mu \) or \( z \) are constant over time \( \implies \) changes in \( u_n \) over time.

**US unempl. average rates:**

<table>
<thead>
<tr>
<th>Decade</th>
<th>Average Un. rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960s</td>
<td>4.4%</td>
</tr>
<tr>
<td>1970s</td>
<td>6.2%</td>
</tr>
<tr>
<td>1980s</td>
<td>7.2%</td>
</tr>
</tbody>
</table>
The numbers suggest an increase in the natural rate over the last 30 years.

**Why has it increased?**

There are many suspects but uncertainty about who is guilty.

The most convincing explanation: change in the composition of US jobs.

In short, a decrease in the wage paid to unskilled workers has led them to be less attached to their jobs, and to spend more time either in unemployment or out of the labor force. [There was a steady decrease in the demand for unskilled workers relative to skilled workers].

\[ \Rightarrow \] Much of the increase in the natural rate can be traced to a higher unemployment rate among the unskilled, which appears in turn to be due to lower relative wages.